EXHIBIT A

JENIKE® & JOHANSON SCIENCE ENGINEERING DESIGN

Carson
Exhibit No. 28
Date: 10-17-17
Audrey M. Barbush, RPR

November 21, 2016

Opinions of John W. Carson, Ph.D.

concerning

Failure of a soybean meal silo supplied by Sioux Steel to Agropecuaria el Avión plant in Tepic, Nayarit, Mexico

Report 70622-1

I. BACKGROUND

Sioux Steel Company ("SSC") manufactures and sells corrugated, galvanized silos[1] for the storage of various commodities. Traditionally SSC's silos were flat bottom, consisting only of a bolted, circular cylindrical section.

Sometime in 2012 SSC developed a line of hopper bottom silos. SSC's Chad Kramer met with Eric Hanson of KC Engineering, P.C. ("KC") during the week of July 16, 2012 and requested a proposal for a design review of "a couple of our hoppers".[2] KC issued a proposal dated July 30, 2012.[3] In this proposal KC described the project as including:

> *...structural engineering analysis and design review of two hopper cones that are proposed for use with [SSC's] 18' diameter and 30' diameter grain bins.*

KC defined their scope of structural engineering services to be:

> *...review drawings and calculations provided by [SSC] and ... produce independent*

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[1] The terms *bin* and *silo* are used interchangeably in the bulk solids industry to describe a vessel or container that stores a bulk solid. I have chosen to use the word *silo* in this report.

[2] Bates PLF 1089

[3] Bates PLF1

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structural models of the hoppers described above using RISA-3D finite-element analysis software.

SSC did not provide their calculations to KC, so KC performed their review using SSC's drawings. Upon completion of their analysis, KC's Mr. Derek Matthies wrote a letter report dated August 28, 2012 to SSC's Mr. Kramer. In this report he advised:

> *...the 18' Diameter Hopper will sufficiently and efficiently support the expected loads however, the 30' Diameter Hopper* ***is not*** *sufficient as designed.*[4]

He went on to state in Conclusions:

> *After completing the RISA model and hand calculations, the controlling combination for the hopper and frame analysis is Load Combination #2 (DL+LL). This combination controls for both the column design and the hopper plates. All of the members and plates for the 18' Diameter Hopper fell within the acceptable material limits for each member. However, the columns for the 30' Diameter Hopper were* ***found to be overstressed by a factor of 1.37*** *and should be replaced with larger columns.*[5]

Through discussions with SSC's Mr. Kramer on September 28, 2012, KC's Mr. Matthies issued Addendum Letter #1 on October 2, 2012. In this letter he revised KC's position with respect to the August 28, 2012 report, finding that

> *...the columns for the 30' Diameter Hopper, as currently detailed, are adequate.*[6]

Javier Ortiz Radillo of Molinos Azteca ("Molinos"), an authorized distributor for SSC located in Mexico, sent an email to Don Delgado, SSC's International Sales and Business Development Manager, on November 20, 2012. In this email he requested a quotation for three model SC3015HOP silos having a volumetric capacity of 1,050 m^3 to store soybean meal with a bulk density of 680 kg/ m^3 (42.4 lb/ft^3) plus a 6% compaction factor. These silos were to have a Flying Dutchman discharge system, a 9.14 m (30 ft) diameter cylinder section, and a 40° cone.[7]

The following day Mr. Delgado talked with Sam Cebula of Pneumat Systems Inc. ("Pneumat") and requested a quote for an air cannon system for each silo. Mr. Cebula recommended ten air cannons per silo.[8]

Mr. Delgado sent an email to Mr. Cebula on December 10, 2012 in which he translated some comments made in Spanish by "the customer". Among other things he stated:

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[4] Bates PLF 3

[5] Bates PLF 4

[6] Bates KC 993

[7] Bates PLF 873

[8] Bates PLF 955

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All of the storage requirements are for 3 days minimum[9]

SSC issued their first proposal for these silos the following day. Included were a 45° cone and ten Pneumat air cannons with an automatic control system for each silo.[10]

This proposal was revised December 12, 2012 for three shorter silos.[11] On October 10, 2013 SSC issued another revised proposal.[12] This was for only one silo of the same size as the first quotation along with ten Pneumat air cannons and automatic control system.

On September 25, 2013 Molinos issued a proposal to Agropecuaria El Avion ("Agropecuaria") for one of the taller SSC silos and ten Pneumat air cannons.[13] Molinos issued what appears to be a duplicate proposal on "2014-01-16", which could be January 16, 2014.

On November 27, 2103 Pneumat's Mr. Cebula sent an email to SSC's Steve Frazer and Mr. Delgado in which he stated:

> *We downsized the 4 air cannons (504 to 304's) we were planning to put on the hopper section because of space limitations.*[14]

SSC prepared a Packing List dated March 5, 2014. Included were one 30 ft diameter silo, six HV-6504[15] air cannons, four HV-304 air cannons, and an automatic control box.

The silo was reportedly first filled on or about January 28, 2015 with 681,820 kg (approximately 750 tons[16]) of soybean meal.[17] No discharge took place for roughly 4 ½ days. On or about February 2, 2015 two employees of Agropecuaria were attempting to discharge the silo when, without warning, some of the vertical seams in the hopper separated causing a catastrophic failure of the silo. The spilled soybean meal and metal debris covered the two workers, who suffered fatal injuries.[18]

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9 Bates PLF 1002

10 Bates PLF 1011-1015

11 Bates PLF 1024-1028

12 Bates PLF 1034-1038

13 Bates PLF 522

14 Bates PLF 994

15 I assume that these are the same as the 504 air cannons mentioned in Mr. Cebula's email.

16 short tons (2,000 lb)

17 ESI report, Bates PLF 1321

18 Report by Rodney Nohr dated March 3, 2015, Bates PLF 430-482

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II. SCOPE OF ENGAGEMENT

My assignment to date has been to review and analyze various documents produced by the litigants in this case, and to opine as to the cause of the collapse and what role, if any, the work performed by KC Engineering in reviewing the design played in causing or contributing to the failure.

III. DESCRIPTION OF SSC'S SILO

The silo consisted of a 30 ft diameter cylinder, a 45° conical hopper with a central outlet, and twenty steel support columns. Twelve, 44 in. tall ring sections formed the cylinder section.[19] The hopper was supplied in two sections – "upper" and "lower" – with twenty "left hand" and twenty "right hand" panels in each.[20]

The ten Pneumat air cannons were arranged with the six larger ones on the cylinder section, 18 in. above the cylinder/cone junction. The four smaller air cannons were located 72 in. (vertically) above the outlet.[21]

The control system included four firing circuits as described in Table 1.[22]

Table 1. Air cannon firing circuits

Circuit number	Air cannon numbers	Location of air cannons
1	1, 3, 5	Cylinder section
2	2, 4, 6	Cylinder section
3	7, 9	Hopper section
4	8, 10	Hopper section

In automatic mode Timer 1 was set for 5 minutes. Output 1 (presumably firing the three air cannons) was on for 2 seconds then turned off. This was followed by Timers 2, 3 and 4 in sequence with the same 5 minute setting for each timer.[23]

IV. MATERIALS REVIEWED

I have reviewed and relied on the following documents:

- Various court documents in this matter
- Various documents produced in Discovery, in particular:
  - Photos (Bates PLF 620-657 and 1191-1196)

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[19] Bates PLF 439

[20] Bates PLF 1323

[21] Bates PLF 585 and 808. Note that, as I describe later in this report, this is different from the description included in Mr. Nohr's report.

[22] Bates PLF 810

[23] Bates PLF 804

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- Documents referenced in this report
- Expert reports:
  - Rodney Nohr of Nohr Engineering Co., LLC dated March 3, 2015
  - Francisco J. Godoy of ESI dated May 11, 2015
  - Mark R. Duckett of Robson Forensic dated October 5, 2016
- Deposition transcript of Chad Kramer taken on September 29, 2016
- ANSI/ASAE EP433 DEC 1998 (R2011), Loads exerted by free-flowing grain on bins, American Society of Agricultural and Biological Engineers, St. Joseph MI, 2011
- AS 3774-1996, Loads on bulk solids containers, Standards Australia, Homebush, NSW, Oct. 1996
- EN 1991-4, Eurocode 1 – Actions on structures – Part 4: Silos and Tanks, European Committee for Standardization, Brussels, May 2006
- Other documents referenced in this report

V. OPINIONS

1. SSC knew that this silo was to be used to store soybean meal and that this material has the potential to be non-free flowing.

As described above, the first request from Javier Ortiz Radillo of Molinos, SSC's authorized distributor in Mexico, to SSC's Mr. Delgado was for the supply of a silo to store <u>soybean meal</u>. All three of SSC's proposals to Molinos stated that the silos were for the storage of "pasta soya" (soybean meal).

SSC's Mr. Kramer was aware that soybean meal is not free flowing, as he indicated in an August 6, 2014 email to SSC's International Sales Director, Les Garcia:

> *Obviously any material requiring these air cannons is not free-flowing.*[24]

Mr. Garcia was concerned about Mr. Kramer's response, as indicated by his email the following day:

> *Now I don't know what to do about the tank that Molinos Azteca [is] installing right now, it is a 3012HB.*[25]

Despite this concern, the silo was erected and, to my knowledge, SSC gave no warning to anyone at Molinos or Agropecuaria as to the problems that could – and unfortunately did – occur.

Mr. Kramer confirmed in his deposition that he knew that soybean meal is not free flowing:

> *...it's not a free-flowing grain.*[26]

[24] Bates PLF 670

[25] Bates PLF 669

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2. **It was not appropriate for SSC to use ASAE EP433 to design the silo, since soybean meal can be non-free flowing.**

   The title of ASAE EP433 is *Loads exerted by free-flowing grain on bins*. (Emphasis is mine.) In Section 1.1 Purpose this restriction is further defined as:

   > *...methods of estimating grain pressures within centrally loaded and unloaded bins used to store free-flowing, agricultural whole grain.*

   Clearly soybean meal is neither "free-flowing" nor a "whole grain"; therefore, ASAE EP433 was not the appropriate design standard that SSC should have used to calculate material-induced pressures on the walls of this silo.

3. **I find it surprising that SSC made a mistake in their design of the bolted joints that formed the hopper radial seams, since they had for years manufactured and supplied bolted cylindrical silos.**

   The equations that govern the strength of a bolted joint are the same whether the joint is in a hopper or cylinder section.

   Mr. Kramer admitted that he made a mistake in the design of the bolted connections of the hopper's radial seams:

   > *Q. And you'll agree with me that the hopper bin should not have gone down to Mexico with utilization ratios at those seams of 3.89 and 1.52?*
   >
   > *A. Yes. There was a math error. Yes.*
   >
   > *Q. And maybe I'm just trying to be too diplomatic, and maybe that's part of our disconnect here. But, I mean, a mistake was made by Sioux Steel in the design of this bin, correct?*
   >
   > *A. Yes. I made a mistake, yes.*
   >
   > *Q. And that mistake is yours?*
   >
   > *A. Yes.*
   >
   > *Q. Post failure you said you made some changes. What changes were made to account for these design errors?*
   >
   > *A. We modified the hopper panels, changed the bolt spacing, the edge distances from the edge of the material to the edge of the bolts, increased that.*[27]

4. **Since KC proposed to perform their review using ASAE EP433 and SSC did not object, it was reasonable for KC to assume that the material to be stored in the silos they were analyzing would be free flowing.**

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[26] Deposition 25:16

[27] Deposition 24:8-23

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In their July 30, 2012 proposal, KC listed four references that they would be using for their review. The second reference listed was ASAE EP433. There is no evidence that SSC objected to this. Indeed they used the same method themselves.

5. KC had no way to know that soybean meal was one of the materials that would be stored in SSC's hopper silos.

There is no mention of soybean meal in KC's July 30, 2012 proposal or in their August 28, 2012 report.

SSC's Mr. Kramer testified as follows:

Q. You'll agree with me that Sioux Steel never informed KC Engineering that soy meal may be used in these hopper bins, correct?

A. We didn't discuss specific commodities.[28]

6. KC lack of review of the design of the hopper radial seams was potentially an oversight on their part.

In reviewing KC's hand calculations that were included with their August 28, 2012 report, pg.1 of 3 dated August 13, 2102 for "Hopper Panel Connection"[29], it is clear that they only analyzed the 3-row horizontal seam at the top of the hopper, not the radial seams.

I have been told that KC did not analyze the radial seams because someone at SSC told them that this was unnecessary. I have no reason to doubt this statement, but KC should have noted this somewhere in their report. By omitting such a statement one could assume that this was an oversight on KC's part; however, as explained below in Opinion 13, even if this joint had been strengthened to meet code requirements, it still would have failed.

7. SSC should have provided information to Agropecuaria as to how to safely operate their silo when storing soybean meal, including, at a minimum, recirculation of the meal.

There is no mention of the need to recirculate the silo contents in SSC's Owner's/User's Manual.[30]

Mr. Kramer testified as follows:

Q. Let's briefly discuss the subject that I think we'll have a lot of agreement on. I'm hopeful. The way that the people in Mexico -- do you have any concerns/criticisms as to how they managed that hopper bin with the soy meal? Do you have any concerns about how they used it?

A. The only information I have on how they used it is based on Rod Nohr's report.

Q. And what do you recall from Mr. Nohr's report about their bin operation?

[28] Deposition 62:22-25

[29] Bates PLF 28

[30] Bates PLF 527-555

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A. I recall that they didn't circulate the soy meal that is standard of practice in the industry, as Rod stated in his report.

Q. How do you know that's standard in the industry that soy meal would be circulated?

A. Based on Rod's report.

Q. I mean you'll agree with me that the operators in Mexico, they bear some responsibility for what happened in that catastrophe down there?

MR. GOODSELL: Object to the form and foundation of the question.

You can answer.

THE WITNESS: Based on Rod's report it sounds like there was some mismanagement of the product within the hopper.

BY MR. TOBIN:

Q. And that mismanagement may well have contributed to the catastrophe?

MR. GOODSELL: Same objection.

THE WITNESS: It could have.

Contrary to Mr. Kramer's testimony, there is no mention of recirculation in Mr. Nohr's report.

8. The manner in which the air cannons were fired further compacted the meal in the silo and significantly increased loads on the silo walls, particularly in the hopper section.

The reason for installing air cannons on a silo is to assist gravity by providing an air pressure gradient that is sufficient to collapse stable arches[31] of cohesive material. If a sufficient number of air cannons are properly placed on a silo, the material discharges through the outlet. If an air cannon is placed too far from an arch surface, the high pressure (reportedly 140 psi) air simply compacts the material, thereby making it more difficult to flow.

There is some disagreement concerning the location and firing sequence of the air cannons. As described above, the Pneumat documents indicate that six air cannons were placed on the lower cylinder section and four just below mid-level in hopper. Mr. Nohr states that there were five in the cylinder and five in the hopper. Photographs taken by Mr. Nohr (and perhaps others) show that the Pnuemat documents are correct.

[31] The terms *arches* and *bridges* are used interchangeably in the bulk solids industry to describe a stable obstruction to flow, usually at a hopper outlet. Similarly, the terms *arching* and *bridging* are used interchangeably to describe this phenomenon.

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Mr. Nohr describes the firing sequence as follows:

> *Per Mr. CASTRO*[32] *and NOHR's understanding, five PNEUMAT air cannons around the circumference of the bin wall base (above the hopper) operated using compressed, dried air with the compressor set at 140 PSI, with one air cannon triggering consecutively in 20-second intervals, working counter-clockwise around the bin. Next, the 5 air cannons located around the bin 's hopper at mid height also operated consecutively at 20 second intervals, working counter-clockwise around the hopper cone before the wall base air cannons operated again, continuing repetitive cycles of operation. A full and complete air cannon firing cycle of the ten (10) air cannon takes about 200 seconds (3.5 minutes) from start to finish. The air cannon firing cycle repeats automatically when operating.*

This differs from the Pneumat documents described above.

No matter who is correct, there is agreement that the upper level air cannons were fired before the lower ones. This is contrary to good operating practice for air cannons.[33] Lower air cannons should always be fired first so as to have the best chance of collapsing an arch. By firing the upper air cannons first, the soybean meal was even more compacted than it would have been if the lower level air cannons were fired first. In addition, there was even more pressure added to the silo's walls, as explained below in Opinion 13.

SSC's Mr. Kramer was properly concerned about the effect of high-pressure air on the silo structure. In his August 6, 2014 email to Mr. Garcia he stated,

> *I still have no idea what kind of loads the cannons would place on the hopper structure...I am more concerned with the eccentric loads that non-free flowing materials could place on the hopper.*[34]

After the accident he provided some history on the supply of this silo and its air cannons.

> *...since soybean meals is not a free flowing grain that there could be significant issues from impact when large amounts of material falls after it bridges.*[35]

9. Moisture migration likely occurred while the meal was sitting in the silo after it was filled. This resulted in even more gain in the meal's cohesive strength than occurred due to gravity-induced compaction pressures alone.

Approximately 750 tons of soybean meal (about 93% of the silo's capacity) sat in the silo for 4 ½ days before an attempt was made to discharge it. During this time the weather changed from warm to cool with rain.

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[32] According to Mr. Nohr, Miguel Castro identified himself as the owner of Agropecuaria

[33] Troxel, T. G: Flow Aids - What to Use and When to Use Them, *Powder Bulk Solids* Advances in Dry Processing 2000, pp. 12-16

[34] Bates PLF 670

[35] Bates PLF 668

It is well known[36,37] that temperature gradients cause moisture to migrate in bulk solids. As ambient temperature changes, silo walls react more quickly than the bulk solid, since metal is a better conductor of heat.

Therefore, as the weather cooled while the soybean meal was sitting at rest in the silo at the Agropecuaria plant in late January and early February 2015, the silo walls cooled quickly while the meal remained at or near the higher temperature that it had when it was placed in the silo. Given that the meal reportedly had a moisture content of 11.5%,[38] the temperature differential between the cooler walls and warmer meal caused moisture to migrate towards the walls.

As the moisture of a bulk solid increases, this almost always results in an increase in the material's cohesive strength, which often leads to caking.

10. Because the conical hopper section had a slope of 45°, a *funnel flow* pattern developed upon discharge. The result was that there would have been no change in material-induced loads acting on the hopper walls from the initial-fill loads <u>unless</u> an arch or rathole collapsed or air cannons compacted the soybean meal.

When an empty silo is filled with material, an *initial fill* material-induced loading condition develops on the silo walls. When discharge commences, this loading condition changes to a *flow* loading condition where there is movement of the bulk solid. Movement only occurs at hopper walls if a *mass flow* pattern develops.[39]

A *mass flow* flow pattern could not have developed in this hopper because of its shape (conical), its slope (45°), and the magnitude of wall friction between the meal and the galvanized steel surface. Instead, a *funnel flow* pattern developed, which resulted in no change in the material-induced loads acting on the hopper walls.[40]

The loads described above are the result of gravity. Other, higher loads will develop if an arch or rathole collapses or if air cannons are fired.

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[36] Purutyan, Herman, Brian H. Pittenger, and Gabriel I. Tardos: "Prevent Caking During Solids Handling", *CEP Magazine*, May 2005

[37] Mehos, Greg and Scott Clement, "Prevent Caking and Unintended Agglomeration", *Chemical Engineering*, August 2008, Volume 115, No. 8, pp. 55

[38] Bates PLF 439

[39] Jenike, A.W., J.R. Johanson, and J.W Carson.: Bin Loads. Part 2: Concepts. J. *Eng. for Industry* 95:1-5 1973. Part 3: Mass-flow bins. *J. Eng. for Industry* 95:6-12, 1973. Part 4: Funnel-flow bins. *J. Eng. for Industry* 95:13-16, 1973

[40] EN 1991-4, Eurocode 1 – Actions on structures – Part 4: Silos and Tanks, European Committee for Standardization, Brussels, May 2006

11. This silo did not fail because of material-induced loads resulting from gravity alone.

Of the three expert reports that I have reviewed, only one (report prepared by Francisco J. Godoy of ESI dated May 11, 2015) includes calculations. Mr. Godoy used two different calculation methods:

- "The design of walls, bins and grain elevators" by Milo Smith Ketchum
- Australian Standard AS3774-1996 "Loads on bulk solids containers"

Mr. Godoy found that neither method of calculation would predict failure of the bolted joints in the hopper:

> *According to the calculations presented apparently a failure would not have occurred; however, some other aspect for the empting process flow has to be considered to obtain the actual pressures and stresses that existed at the moment of the accident.*[41]

Mr. Godoy's calculations show that, while the loads do not predict failure, the edge distance to satisfy *allowable* design requirements is larger than the smallest actual edge distance in the SSC hopper (0.719 in.) This is because the codes require the calculated minimum edge distance (for failure) to be doubled for a factor of safety.

In order to predict failure Mr. Godoy had to multiply his calculated loads by a factor of 1.4, which he arrived at by considering ASAE EP433. This approach is flawed because:

1. There is no rationale to calculate loads by one standard or method then multiply those loads by a factor obtained from another standard or method.
2. As I have explained above, ASAE EP433 is not an applicable standard for a silo storing soybean meal.
3. Mr. Godoy incorrectly interprets *plug flow* as described in ASAE EP433. In his report he stated:

> *The uneven stored material consolidation causes an erratic flow of the material during discharge process due to material 'arching or bridging' formations and then their eventual collapse that would cause extra dynamic loads which would cause extra pressures or 'overpressures' on the cone shell (Ref. 6 and 11). As the material empting process continues those bridging-collapse mechanisms keep occurring as the bottom material layers flow down; this type of flow pattern is also called 'plug flow'.*

As explained in the Commentary Section 5.1.2.2 of ASAE EP433:

> *Plug flow is defined as flow from a bin in which all or part of the material moves as a unit, with material movement along the bin walls.*

As I explain above, movement could not occur along the walls of this silo's hopper; instead, a *funnel flow* pattern developed. Commentary Section 5.1.2.1

41 Bates PLF 1333

makes it clear that for this flow pattern,

> *...overpressures are not generated*

4. Mr. Godoy's (incorrect) definition of plug flow describes conditions (*erratic flow ...'arching or bridging'*) that could not occur if the stored material was free flowing.

12. SSC's Mr. Kramer was aware that higher material-induced loads should have been used to design the hopper section.

Mr. Kramer sent an email to my firm, Jenike & Johanson, Inc. on July 17, 2012 that read as follows:

> *I am a structural engineer at Sioux Steel Company in Sioux Falls, SD. We recently designed a line of bolt together hoppers for use with grain bins in diameter from 18' to 36'. Since we're new to hopper design, we are looking for someone to do a design review of a couple of the hoppers. Would your firm be able to undertake a project like this?*

Tom Baxter, one of our Sr. Consultants, followed up by email the same day. He asked Mr. Kramer for more information on the silo design, type(s) of grain being handled, and what level of review they (Sioux) needed. Mr. Kramer replied the same day in an email:

> *We're more interested from [sic] a design review from a structural perspective. I've attached an assembly drawing of our 18' hopper. This hopper was designed for an 18' diameter bin with an eave height up to 33' high be on it. Our bins consist of corrugated galvanized sheets which are bolted together as well. The hopper bins are designed for materials with a bulk density of up to 55.3 lb/ft^3. If you need additional information in order to give me an idea on what your fee would be for this type of design review let me know.*

Mr. Baxter forwarded this information to Greg Petro, one of our Sr. Structural Engineers, who had a phone conversation with Mr. Kramer on July 19, 2012. Mr. Petro concluded from his conversation that the loads that Jenike & Johanson engineers would use to design such silos would be higher than what SSC was using; therefore, there was no need to prepare a proposal since there was no likelihood that SSC would accept it.

13. The silo failed because the loads that were imposed on the hopper section were greater than the loads due to gravity alone.

The reasons are as follows:

- The silo did not fail when it was filled the first time, and it did fail the first time an attempt was made to discharge it.[42]
- Prior to the failure, the air cannons had been operating for about 10 minutes and operators were hammering on the hopper.[43]

[42] ESI report, Bates PLF 1321

[43] Nohr report, Bates PLF 441-2

- Only a small amount of soybean meal discharged before some of the radial hopper seams split open.[44]
- As I discuss above, even though gravity-induced loads stressed the radial bolted joints beyond their allowable limit, they were not stressed to the point that they would have failed.
- Clearly, therefore, loads greater than those imposed by gravity alone were required to fail the silo. Two loading conditions were likely present prior to the failure, either of which would have imposed significantly larger loads on the hopper section than gravity alone. These are:
    - Dynamic loads caused by a collapsing arch or rathole. It is well known that the dynamic loads that occur when an arch or rathole fails can collapse a silo.[45,46]
    - Dynamic loads as a result of firing the air cannons. According to Mr. Nohr, the air cannons were pressurized to 140 psi.[47] Each time that an air cannon was fired into this silo, significant additional pressure was immediately exerted on the adjacent hopper or cylinder wall,[48] the magnitude of which was <u>at least</u> ten times greater than the gravity-induced pressures acting on the hopper walls.
- Mr. Nohr is the only person who has reported viewing the security camera video of the silo collapse. He stated in his report that the failure started near the bottom of the hopper and progressed upward.[49] Since the hoop stresses generated by the gravity-induced pressures acting on the hopper walls were considerably smaller in the lower portion of the hopper than higher up, this is further indication that loads greater than those imposed by gravity alone caused the silo to fail.

VI. CONCLUSIONS

To a reasonable degree of engineering certainty, I am of the opinion that failure of the soybean meal silo was caused by the reasons stated herein, including:

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44 ibid

45 Carson, J.W.: Silo Failures: Case Histories and Lessons Learned. Proceedings of The 3rd Israeli Conference for Conveying and Handling of Particulate Solids, Vol. 1, p. 4.1 - 4.11, 2000.

46 G. Gurfinkel, Tall Steel Tanks: Failure, Design, and Repair, *ASCE Journal of Performance of Constructed Facilities*, Vol. 2, No. 2, May 1988, pp. 99 to 110

47 Bates PLF 441

48 AS 3774-1996, Loads on bulk solids containers, Standards Australia, Homebush, NSW, Oct. 1996

49 Bates PLF 442

1. A non-free flowing material, soybean meal, was stored in it.

2. SSC failed to provide information to Agropecuaria as to how to safely operate this silo.

3. The air cannons, which were supplied by SSC, compacted the soybean meal in the silo prior to its failure.

4. Allowing the soybean meal to sit in the silo without movement for 4 ½ days while the ambient temperature dropped further compacted the meal.

5. The silo did not fail due to material-induced loads resulting from gravity alone.

6. The silo failed because significantly higher, dynamic loads were imposed on its hopper section than the loads caused by gravity alone. These loads were due either to a collapsing arch or rathole or due to the firing of the air cannons.

VII. BASIS OF OPINIONS

I relied on my educational background, training, and experience as well as the collective expertise of other engineers within my firm, to develop my opinions to a reasonable degree of engineering certainty. I also relied on documents, photographs, and videos that have been exchanged between the parties. I reserve the right to modify and amend my opinions as additional information becomes available and to issue rebuttal opinion in response to the opinions of other experts.

VIII. RELEVANT EXPERIENCE

My firm, Jenike & Johanson, Inc., is generally recognized as the world's leading authority on the science and engineering of bulk solids flow, processing, and storage. I have spent my entire professional career – over 45 years – working in this field. In addition to serving as an engineering consultant solving or preventing bulk solids handling, processing and storage problems in industrial plants around the world, I have taught this subject to literally thousands of engineers through short courses, performed research in this field, and served as an expert witness in well over 50 litigations. I have worked extensively – both as an engineering consultant and as an expert witness – in the areas of silo design, silo loads, silo inspections, and silo failures. I have testified in federal and state courts as well as before arbitration panels. Appendix A contains my CV, which includes my testifying experience during the last four years. Appendix B lists publications that I have authored or co-authored during my career.

IX. COMPENSATION

My hourly rate is $400, and my fee for testifying is $3,500 per day plus expenses.

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Respectfully submitted,

John W. Carson, Ph.D.
President
Tyngsboro, Massachusetts

jwcarson@jenike.com

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Appendix A

CV and testifying experience of Dr. John W. Carson

JENIKE & JOHANSON

JOHN W. CARSON, Ph.D.
President, Jenike & Johanson

September 2016

EDUCATION

Ph.D. (Mech. Eng.), M.I.T., Cambridge – 1971
M.S. (Mech. Eng.), M.I.T., Cambridge – 1968
B.S. (Mech. Eng.), Northeastern University, Boston – 1967

EXPERIENCE

1970 – present **Jenike & Johanson, Inc.**
Tyngsboro, MA
President. Consulting engineer specializing in the storage and flow of bulk granular solids. Involved in all areas of the company's activities including research, development, lecturing, marketing, personnel and management.

1965 – 1966 **U.S. Steel Corp., Applied Research Lab**
Monroeville, PA
Co-op student employed in Materials Handling and Equipment Development section. Assisted in research on flow-corrective inserts in hoppers and bins. Developed a method of friction-plate sizing for bulk granular solids.

PROFESSIONAL SOCIETIES

- American Society of Engineers
- American Institute of Chemical Engineers, Founding Member of Particle Technology Forum
- American Society of Mechanical Engineers
- ASTM International, Founding Member and Chair of D18.24 "Characterization for Handling Powders and Bulk Solids

HONORS AND AWARDS

- Particle Technology Forum award, presented by American Institute of Chemical Engineers, in recognition of, "lifetime outstanding scientific/technical contributions to the field of particle technology, as well as leadership in promoting scholarship, research, development, or education in this field". June 2015
- Permanently Invited Guest to European Federation of Chemical Engineering's Working Party Mechanics of Particle Solids, 2007 – present
- Solids Handling Award, presented by The Institute of Mechanical Engineers (Britain) "in recognition of professional excellence in bulk solids handling technology," presented at 7th World Congress of Chemical Engineering, Glasgow, July 2005

TESTIFYING EXPERIENCE DURING LAST FOUR YEARS

- Green Plains Bluffton, LLC and Green Plains Obion, LLC, Claimants v. Fagen, Inc., Respondent and Third-Party Claimant, and Hogenson Construction Co., Third-Party

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Respondent, American Arbitration Association, Minneapolis MN, Case No. 50 122 T 000054 10

- Secretary of Labor, U.S. Dept. of Labor, Mine Safety and Health Admin. (MSHA), Petitioner v. Norlite Corp., Respondent, Federal Mine Safety and Health Review Commission, Case No. YORK 2012-119M
- ALSTOM Power Systems Gmbh and ALSTOM Bulgaria EOOD, Claimants v. AES-3C Maritza East 1 EOOD, Respondent, UNCITRAL Arbitration, London, England
- Phosagro Asia Pte. Ltd (Singapore), Claimant V. Chin Joo Heng Co., Ltd (Thailand), Respondent, International Chamber of Commerce, International Court of Arbitration, Reference No. 20173/Cyk
- Marie Jozie Pierre a/k/a Marie Jozie Pierre Mezidor, as Personal Representative of the Estate of Pierre Sonny Mezidor, deceased, Plaintiff, v. TARMAC America LLC, a foreign corporation d/b/a Titan America; McGregor General Contracting, Inc., a Florida corporation d/b/a MGC, Inc.; et al., Defendants, Circuit Court of the Eleventh Judicial Circuit in and for Miami-Dade County, Florida Circuit Civil Division, Case No. 12-33204 CA 25
- Jerry Lee Cornell v. Mississippi Lime Co. v. Wellsville Terminal Company, Columbiana County (Ohio), Court of Common Pleas, Case No. 2013 CV 00597
- SNF Holding Company, Flopam Inc., Chemtall Incorporated, SNF SAS, and SNF (China) Flocculant Co. Ltd., *Petitioners* v. BASF Corporation, *Patent Owner*. Patent Trial and Appeal Board, United States Patent and Trademark Office, Case IPR2015-00600 re: Patent 5,633,329
- Spectraserv, Inc., Plaintiff v. Middlesex County Utilities Authority, R3M Engineering, Inc., et al., Defendants, Superior Court of New Jersey, Middlesex County, Case No. MID-L-2577-07
- Jeld-Wen, Inc. Plaintiff v. Gateway Tank, Inc. and The Cincinnati Insurance Company, Defendants, US District Court, Western District of Louisiana, Alexandria Division, Civil Action No. 1:13-cv-03172
- Dynamic Air Inc., *Petitioner* v. M-I Drilling Fluids UK Ltd., *Patent Owner*, United States Patent and Trademark Office, Patent Trial and Appeal Board, Cases IPR2016-00256 re: Patent 6,702,539 B2, IPR2016-00259 re: Patent 7,544,018 B2, IPR2016-00260 re: Patent 7,033,124 B2, IPR2016-00262 re: Patent 7,186,062 B2, IPR2016-00263 re: Patent 7,186,062 B2, and IPR2016-00264 re: Patent 6,709,217 B2
- PCS Sales (USA), Inc., Plaintiff v. Kinder Morgan Operating, L.P. "C" and Electrical Engineering Enterprises, Inc., Defendants, Circuit Court of the Thirteenth Judicial Circuit in and for Hillsborough County, Florida, Civil Division, Case No. 12-002965 Division K

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Appendix B

Publications authored or co-authored by Dr. John W. Carson

JENIKE & JOHANSON
SCIENCE ENGINEERING DESIGN

July 12, 2016

PUBLICATIONS BY JOHN W. CARSON, Ph.D.

1. "Numerical Elastic-Plastic Analysis in Plane Strain" S.M. Thesis, Dept. of Mech. Eng., M.I.T., 1968.

2. "A Study of Plane Strain Ductile Fracture," Ph.D. Thesis, Dept. of Mech. Eng., M.I.T., 1970.

3. "Bin Loads - Part 2: Concepts," with A.W. Jenike and J.R. Johanson, ASME, J. Engr. Ind., Vol. 95, Ser. B, No. 1, Feb. 1973, pp 1-5.

4. "Bin Loads - Part 3: Mass Flow Bins," with A.W. Jenike and J.R. Johanson, ASME, J. Engr. Ind., Vol. 95, Ser. B, No. 1, Feb. 1973, pp 6-12.

5. "Bin Loads - Part 4: Funnel Flow Bins," with A.W. Jenike and J.R. Johanson, ASME, J. Engr. Ind., Vol. 95, Ser. B, No. 1, Feb. 1973, pp 13-16.

6. "Feeding Fine Solids with Mass Flow Bins," with A.W. Jenike, Chem. Engr. Progress, Vol. 71, No. 2, Feb. 1975, pp 69-70.

7. "Applying Bulk Solid Flow Principles to Metal Powders," Int'l. J. Powder Metallurgy & Powder Tech., Vol. 11, No. 4, Oct. 1975, pp 233-239.

8. "Rapid Analysis of Flow Properties for Bin Design," with J.R. Johanson, Int'l. Powder & Bulk Solids Handling & Processing Conf., Rosemont, IL, May 1976.

9. "Nonlinear Finite Element Analysis of Gas Flow in a Contact Bed Reactor," with I. Fried, Second Int'l. Symposium on Finite Element Methods in Flow Problems, Portofino, Italy, June 1976.

10. "Vibrations Caused by Solids Flow in Storage Bins," with J.R. Johanson, Int'l. Powder & Bulk Solids Handling & Processing Conf., Rosemont, IL, May 1977.

11. "Storage and Feeding of Coal," with A.W. Jenike. Presented at ERDA Conference on Coal Feeding Systems, Pasadena, CA, June 1977.

12. "Feeding Coal into a Pulverizer at Monsanto's Soda Springs Plant," with W. Womack and W.

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Tufts, Powder & Bulk Solids Conf., Rosemont, IL, May 1978.

13. "Nuclear Fuel Powder Flow Characterization," with P.J. Densley, American Ceramic Society, Cincinnati, OH, May 1979.

14. "Brookville Solves Fine Limestone Feed Problem," with L.G. Laszlo and L. Williams, Powder & Bulk Solids Conference, Philadelphia PA, May 1979.

15. "Measuring the Effectiveness of a Freeze Conditioning Agent," National Coal Freeze Conference, Cincinnati, OH, March 1980.

16. "Solving Coal Flow Problems at Detroit Edison Co.," with M. Moaveni, Coal Handling and Storage Symposium, Chicago, June 1980.

17. "Pressurized Hopper," with P.J. Densley and L.H. Goldman, Jr., American Ceramic Society, San Francisco, CA, Oct. 26-29, 1980.

18. "Establishing Reliable Coal Flow in Power Plants," with J. Marinelli, Power Engineering, Nov. 1981, pp 90-93.

19. "Design of Bins and Feeders for Reliable Minerals Flow," Mining Engineering, Vol. 35, No. 3, March 1983, pp 229-234.

20. "Reliable Flow from Bins, Feeders and Transfer Points," 8th Annual Powder & Bulk Solids Conference, Atlanta, May 1983.

21. "How to Ensure Reliable, Controlled Flow at a Bulk Terminal," 4th Bulk Handling and Transport Conference, Amsterdam, June 1983.

22. "The Design of Large Coal Silos for Safety, Reliability and Economy," Bulk Solids Handling, Vol. 4, March 1984, pp 173-177.

23. "The Importance of Material Flow Characteristics in Storage Tank Selection," with J.R. Farris, Powder/Bulk Solids, April 1984 and Plant Operation and Optimization, ed. by Gail F. Nalven, 1996, pp 327-337.

24. "How to Design Power Plant Standpipes to Work Reliably," with J. Marinelli, Coal Technology '85 Conference, Pittsburgh, Nov 1985.

25. "Understanding and Eliminating Particle Segregation Problems," with T.A. Royal and D.J. Goodwill, Bulk Solids Handling, Vol. 6, Feb 1986, pp 139-144.

26. "Preventing Solids Flow Problems," with J. Marinelli, Powder/Bulk Solids, January 1986, pp 23-25.

27. "Interfacing Storage Bins with Pneumatic Conveying Systems," with A.R. Reed, J.S. Mason

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and D.G. Goodwill, Powder & Bulk Solids 11th Annual Conference, Rosemont, IL, May 1986, pp 698-733.

28. "Measurement Principles of the Flowability of Powders," with A.W. Jenike, 1986, Conference on Ceramic Powder Science and Technology, Boston, Mass., August 1986.

29. "The Handling of Heaps," with T.A. Royal and D.S. Dick, Mechanical Engineering, November 1986, pp 51-59.

30. "Pneumatic Conveying: Principles of Operation," with D.T. Bridge, Powder/Bulk Solids, August, 1986 pp 23-28.

31. "How to Design Efficient Screw and Belt Feeders for Bulk Solids," with D.T. Bridge, Powder and Bulk Solids 12th Annual Conference, Rosemont, IL, May 1987, pp 315-324.

32. "Soybean Meal Flow Problems Solved at Agri and Staley," with D.J. Goodwill and W. Dohrmann, Power Engineering, March 1988, pp 24-27.

33. "Interfacing Bulk Solids Conveyors with Upstream Equipment," AIChE, New York, November 1987.

34. "New Developments in Characterizing and Improving the Flow of Bulk Granular Solids," with D.S. Dick, Mining Engineering, March 1989, pp 163-165.

35. "Addressing Critical Solids Handling Aspects at the Pilot Scale." AIChE, New Orleans, March 1988.

36. "Solutions to Typical Materials Handling Problems in Iron and Steel Plants," with D.J. Goodwill, AIME, Iron and Steel Society, Toronto, April 1988.

37. "Solutions to Typical Materials Handling Problems When Storing Grains," with D.S. Dick, ASAE, Rapid City, SD, June 1988.

38. "Overcoming Particle Segregation in the Pharmaceutical and Cosmetic Industries," Drug Development and Industrial Pharmacy, Vol. 14, No. 18, 1988.

39. "Designing Efficient Screw Feeders." Powder and Bulk Engineering, Vol. 1, No. 12, December 1987, pp 32-42.

40. "Seals Improve Coal Flow into a Pressurized Environment," with D.S. Dick, Power Engineering, March 1988, pp 24-27.

41. "Powder Handling in the Ceramics Industry," Ceramic Bulletin, May 1988.

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43. "Feeding Solids Into a Fluidized Bed Combustor," Powder Handling & Processing, Vol. 3 No. 4, Nov. 91, pp 343-345.

44. "How Bin Retrofits Can Correct Flow Problems," with D.S. Dick, Powder Handling & Processing, Vol. 12, No. 2, May 92, pp 245-249.

45. "Modeling Bulk Solids Flow," with T.A. Royal, Powder Handling & Processing, Vol. 3, No. 3, Sept. 91, pp 251-261.

46. "How to Prevent Silo Failure with Routine Inspections and Proper Repair," with R.T. Jenkyn, Powder and Bulk Engineering, Vol. 4 No. 1, January 1990.

47. "In-Bin Blending Improves Process Control," with T.A. Royal, Powder Handling & Processing, Vol. 4 No. 3, Sept. 92, pp 301-307.

48. "North American Advances in the Design of Silos, Bins and Hoppers," Bulk Solids Handling, Vol. 11, No. 1, March 1991, pp 37-46.

49. "Fine Powder Flow Phenomena in Bins, Hoppers and Processing Vessels," with T.A. Royal, Bulk 2000, 1991.

50. "Techniques of In-Bin Blending," with T.A. Royal, Bulk 2000, 1991.

51. "Predicting the Shape of Flow Channels in Funnel Flow Bins and Silos," with D.J. Goodwill and K.E. Bengtson, 1991 Spring Convention, American Concrete Institute, Boston, MA, March 17-21, 1991.

52. "Toward a Better Understanding of the Storage and Flow of Bulk Materials," Bulk 2000: Bulk Material Handling Towards the Year 2000, London, October 29-31, 1991.

53. "Reliable and Economical Handling of Bulk Solids at Coal-fired Power Plants," with R.T. Jenkyn and J.C. Sowizal, Bulk Solids Handling, Vol. 12, No. 1, Feb. 1992, pp 11-18.

54. "Solve Solids Flow Problems in Bins, Hoppers, and Feeders," with J. Marinelli, Chemical Engineering Progress, May 1992, pp 22-28.

55. "Use Screw Feeders Effectively," with J. Marinelli, Chemical Engineering Progress, Vol. 88, No. 12, Dec. 1992, pp. 47-51.

56. "How to Avoid Flooding in Powder Handling Systems," with T.A. Royal, Powder Handling & Processing, Vol. 5, No. 1, March 1993, pp 63-68.

57. "Flow-Induced Silo Vibrations," with H. Purutyan and K.E. Bengtson, May 1993 Powder & Bulk Solids Conference/Exhibition in Chicago.

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58. "Load Development and Structural Considerations in Silo Design," with R.T. Jenkyn, Presented at Reliable Flow of Particulate Solids II, Oslo, Norway, August 1993.

59. "Quality Control Tester to Measure Relative Flowability of Powders," with D.A. Ploof. Bulk Solids Handling, Vol. 14, No. 1, Jan./March 1994, pp 127-132 and presented at Oslo Conference, 1993.

60. "The Importance of Storage, Transfer, and Collection," with T.M. Knowlton, G.E. Klinzing, and W.-C. Yang, Chemical Engineering Progress, April 1994.

61. "Tumble Blending with Mass Flow Containers Improves Productivity and Quality," with T.A. Royal and R.J. Hossfeld, Powder Handling & Processing, Vol. 6 No. 4, Oct./Dec. 1994, pp 413-416.

62. "Characterize Bulk Solids to Ensure Smooth Flow," with J. Marinelli, Chemical Engineering, Vol. 101, no. 4, April 1994, pp 78-90.

63. "Identifying and Controlling Silo Vibration Mechanisms: Part I," with H. Purutyan and K.E. Bengtson, Powder and Bulk Engineering, Vol. 8, No. 11, Nov. 1994, pp 58-65.

64. "Identifying and Controlling Silo Vibration Mechanisms: Part II," with H. Purutyan and K.E. Bengtson, Powder and Bulk Engineering, Vol. 8, No. 12, Dec. 1994, pp 19-28.

65. "Bulk Solids Purge and Conditioning Vessels: Designing and Retrofitting for Optimum Performance," with T.A. Royal, and B.H. Pittenger, Chemical Processing , Vol. 58, No. 8, Aug. 1995, pp 77-80.

66. "How to Mix Dry Bulk Solids and Maintain Blend Integrity," with T.A. Royal and T.G. Troxel: 1995. Presented at AIChE Conference in Miami.

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68. "Uniform Conditioning of Bulk Solids in Processing Vessels," with J.K. Prescott, H. Purutyan, and T.A. Royal, Presented at CHISA '96 in Prague.

69. "Mix Dry Bulk Solids Properly and Maintain Blend Integrity," with T.A. Royal and T.G. Troxel, Chemical Engineering Progress, Nov. 1996, Vol. 91, No. 11, pp 72-80.

70. "Measuring Relative Flowability of Powders," with D.A. Ploof. Ceramic Industry, Jan. 1997.

71. "Feeder Selection Guidelines," with G.J. Petro, Chemical Processing, Powder and Solids Annual, 1997, pp 40-43.

72. "Solve Solids Handling Problems by Retrofitting," with H. Purutyan and B.H. Pittenger, Chemical Engineering Progress, April 1998, Vol. 94/No. 4, pp 27-39.

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73. "Controlling Segregation when Feeding to Agglomerators," with B.H. Pittenger, The Institute for Briquetting and Agglomeration, Proceedings, Vol. 25, Oct. 1997, pp. 25-36.

74. "Hopper Selection Guidelines," Chemical Processing, 1998 Powder & Solids Annual, pp. 31-34.

75. "Feeder Selection Tips," Chemical Processing, 1998 Powder & Solids Annual, pp. 48-51.

76. "Blending Case Studies of Highly Segregating Bulk Solids," with D.A. Craig and T.A. Royal, ICBMH '98, 6th International Conference on Bulk Materials Storage Handling and Transportation, pp. 397-403.

77. "Effects of Surface Topography and Particle Size on Powder/Surface Friction Characteristics," with J.K. Prescott: Presented at AIChE Meeting in Miami, November 1998.

78. "Hopper Selection Guidelines," Chemical Processing, 1999 Powder & Solids Annual, pp. 24-28.

79. "Guidelines for Sizing Hopper Outlets, Gates," Chemical Processing, 1999 Powder & Solids Annual, pp. 36-38.

80. "Feeder Selection Tips," with G.J. Petro, Chemical Processing, 1999 Powder & Solids Annual, pp. 39-42.

81. "Bulk Properties of Powders," with B.H. Pittenger, ASM Handbook - Powder Metal Technologies and Applications, Vol. 7, pp. 287-301.

82. "Developing a Better Understanding of Wall Friction," with J.K. Prescott and D.A. Ploof, Powder Handling & Processing, 1/99.

83. "Analyzing and Overcoming Industrial Blending and Segregation Problems," with J.K. Prescott. Presented at International Union of Theoretical and Applied Mechanics Conference, Segregation in Granular Flows, June 5-10, 1999, Cape May, NJ.

84. "Gravity Flow Processing Vessels," Chemical Processing, 8/99, pp. 49-53.

85. "Practical Approaches to Achieving Mass Flow - When 'Standard' Design Techniques Fail," with K.V. Jacob, International Symposium Reliable Flow of Particulate Solids III Proceedings, 11-13 Aug. 1999, Porsgrunn, Norway, pp. 537-544.

86. "Design Considerations when Silos are used as Processing Vessels," with K.V. Jacob, J.H. Lee and B.H. Pittenger, International Symposium Reliable Flow of Particulate Solids III Proceedings, 11-13 Aug. 1999, Porsgrunn, Norway, pp. 553-560.

87. "Six Steps to Designing a Storage Vessel that Really Works," with H. Purutyan and B.H.

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Pittenger, Powder and Bulk Engineering, November 1999, Vol. 13, No. 11, pp. 56-68.

88. "Sizing Hopper Outlets and Gates ± Step-by-Step," Chemical Processing, 2000 Powder & Solids Annual.

89. "Guidelines for Bin Selection," Chemical Processing, 2000 Powder & Solids Annual.

90. "Step-by-Step Process in Selecting a Feeder," Chemical Processing, 2000 Powder & Solids Annual.

91. "Silo Failures: Case Histories and Lessons Learned," Proceedings of The 3rd Israeli Conference for Conveying and Handling of Particulate Solids, Vol. 1, p. 4.1-4.11, 2000.

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93. "Benefits of Global Standards for Shear Testing," Presented at AIChE Conference, Los Angeles, California, November 2000

94. "Understanding the Effects of Temperature on Bulk Solids Flow," with H. Purutyan, Chemical Processing, October 2000, pp. 45-51

95. "The Development of Silo Technology in North America Over the Last Twenty Years," Bulk Solids Handling, Volume 21, Number 2, March/April 2001, pp. 133-147

96. "Why Silos Fail," Powder and Bulk Engineering, Volume 15, Number 11, November 2001, pp. 31-43

97. "A Preliminary Investigation Concerning the Effect of Particle Shape on a Powder's Flow Properties," with M. Bumiller and J. Prescott, Presented at the World Congress on Particle Technology IV, Sydney, Australia, July 2002

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100. "The Selection and Sizing of Bins, Hopper Outlets, and Feeders," Mineral Processing Plant Design, with T. Holmes, Society of Mining Engineers 2002, Ken Boyd Editor

101. "Solids Handling Issues in Thermal Drying Processes," with H. Purutyan and T. G. Troxel

102. "Development of an International Standard for Shear Testing," with H. Wilms, Presented at the AIChE Annual Meeting, Los Angeles, California, 2000 and PARTEC, Nuremberg, 2001

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107. "How to Avoid Common Shear Testing Mistakes," with D. A. Ploof, Presented at the 4th International Conference for Conveying and Handling of Particulate Solids, Budapest, Hungary, May 27-30, 2003

108. "The Dangers of Relying on Wall Friction Values in Codes," with H. Purutyan and J. M. Rotter, presented at the 4th International Conference for Conveying and Handling of Particulate Solids, Budapest, Hungary, May 27-30, 2003

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113. "A valuable new tool for inventory analysis of bulk solids storage vessels operating with a funnel flow pattern" with T.A. Royal and B.H. Pittenger, presented at 7th World Congress of Chemical Engineering, Glasgow, July 2005

114. "Troubleshooting Feeders", Powder and Bulk Engineering, December 2005, pp 19-26

115. "How to Improve the Reliability of Bins and Silos", Plant Services, March 2006, pp 50-52

116. "Predicting Flow Behavior of Solids After Fifty Years Storage Using Sampling and Flowability Studies" with Brian H. Pittenger and Mike Griffon of Fluor Fernald, presented at 5th World Congres on Particle Technology, Orlando, March 2006

117. "Increase Powder Flow via Gas Injection" with Herman Purutyan and Thomas G. Troxel, Chemical Engineering Progress, July 2006, Volume 102, No. 7, pp. 38-43

118. "Development of an international standard for shear testing" with Harald Wilms of Zeppelin Silos & Systems GmbH, Powder Technology, 2006, Volume 167, pp. 1-9

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120. "Interfacing Belt Feeders and Hoppers to Achieve Reliable Operations" with Francisco Cabrejos and Michael Rulff, at SME Bulk Materials Handling Symposium, as part of 2008 SME (The Society of Mining, Metallurgy and Exploration)
121. "Problems of Scale-up of Solids Handling Processes" with Thomas Troxel and Eric Bengtson, in "Piloting and Scale-up of Particle Processes"
122. "Andrew Jenike: Personal Reflections", AIChE Annual Meeting 2007, Salt Lake City, Utah, November 9, 2007
123. "Honoring a Bulk Solids Pioneer", Ceramic Industry, April 2008
124. "How to minimize feed segregation to an agglomeration", Powder and Bulk Engineering, February, 2008 Vol. 22, No. 2, pp. 21 – March, 2008 Vol. 22, No. 3, pp55
125. "Particle technology is alive and well", Powder and Bulk Engineering, Industry Perspective, September 2006
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127. "Effective Design of Belt Feeder Interfaces to Achieve Reliable Operation",with Francisco Cabrejos and Michael Rulff, Int'l Symposium, Reliable Flow of Particle Solids IV, Tromso Norway, June 2008
128. "Scaling up solids handling processes equipment: Limits of theory and scale modeling" with Thomas G. Troxel and Kermit E. Bengtson, Int'l Conference, Structure and Granular Solids, Royal Soc. of Edinburgh, June 30-July 2, 2008
129. "Preparing the Removal of Low-level Radioactive Waste – Predicting the Flow Behavior of Solids after Fifty Years Storage Using Sampling and Flowability Studies" with B.H. Pittenger and M. Griffin, Bulk Solids Handling, August 2008, Volume 28, No. 5, Page 306
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131. "Analsis of Stability of Vessels Laden with Fine, Dry Powders" with M. Esaki, D. Goodwill, and E. Bengston, 6th World Congress on Particle Technology, Nuremberg, April 2010
132. "Troubleshooting Your Screwfeeder", Powder and Bulk Engineering International, March 2011, Vol. 4, No. 2
133. "Unloading non-free-flowing coal from railroad bins", Powder and Bulk Engineering International, March 2012, Vol. 5, No.2
134. "Treat silos with respect", Powder & Bulk Engineering, Industry Perspective, Volume 27, Number 7, July 2013
135. "Ask An Expert: Loading Carbon Black", Powder and Bulk Engineering International, Volume 7, Number 1, January 2014
136. "Limits of silo design codes", Practice Periodical on Structural Design and Construction, Amer. Soc. of Civil Engr., 2014
137. "Don't forget the bulk material's properties", Powder and Bulk Engineering, Industry Perspective, Volume 28, Number 9, September 2014, p.8
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139. "Silo design codes: Their limits and inconsistencies", with D. A. Craig, presented at 7th World Congress on Particle Technology, Beijing, May 2014, Procedia Engineering, (2015), pp. 647-656

140. "Andrew Jenike: A true visionary in Particle Technology", presented at 7th World Congress on Particle Technology, Beijing, May 2014, Procedia Engineering, (2015), pp. 657-660

141. "Growing recognition of importance of bulk solids", Powder and Bulk Engineering, Industry Perspective May 2015

142. " Corrosion and erosion: a dangerous combination in bins and silos", with R. Barnum, C. Hartford, A.Kulkarni, Australian Bulk Handling Review, September/October 2015

143. "Growing recognition of importance of bulk solids", Powder and Bulk Engineering Vol. 29, No.5, May 2015, p. 8

144. "Addressing Segregation of a Low Dosage Blend", with T. Baxter, Presented at AIChE 2015 Annual Meeting, Salt Lake City, Utah, November 8-13, 20

145. "Characterize Bulk Solids to Ensure Smooth Flow", with B. Pittenger and J. Marinelli, Chemical Engineering, April 2016, pp. 50 - 59